Body of Knowledge

Field Use of Direct-Reading Instruments for Detection of Gases and Vapors

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About AIHA®

Founded in 1939, the American Industrial Hygiene Association® (AIHA®) is one of the largest international associations serving the needs of industrial/occupational hygiene professionals practicing in industry, government, labor, academic institutions, and independent organizations.

For more information, visit **www.AIHA.org**

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Background

AIHA® and its members and volunteers worked collaboratively to develop the technical framework, known as the Body of Knowledge (BoK), that outlines the knowledge and skills a competent person should possess and be able to demonstrate when operating direct-reading instruments (DRIs) for detection of gases and vapors. The subject-matter-expert project team included representatives from the AIHA® Real-Time Detection Systems Committee, the International Association of Fire Fighters (IAFF), the Marine Chemist Association (MCA), the National Institute of Occupational Safety and Health (NIOSH), the industrial hygiene and environmental professions, and instrument manufacturers.

In September 2014, a panel of subject-matter experts was selected to refine the list of knowledge and skills that persons at the technician and professional levels need to competently use multi-gas meters, photoionization detectors (PIDs), and similar DRIs used in screening for airborne contaminants. As a result, a draft BoK was created and provided as a Job/Task Analysis (JTA) survey to collect input, perspective, and feedback from relevant stakeholders to identify the essential knowledge and skills required for competent field use of DRIs for detection of gases and vapors.

In November 2014, the JTA survey was made available to external stakeholders, allied professionals, and AIHA® members and volunteers. The survey results were used to finalize the content for the Field Use of Direct-Reading Instruments for Detection of Gases and Vapors BoK.

The BoK document was approved by the subject-matter-expert project team and the AIHA® Board of Directors in March 2015 and May 2015, respectively.

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Detection of Gases and Vapors

Occupational Definition:

This document provides an organized summary of the collective knowledge and skills necessary for competent field use of direct-reading instruments (DRIs) for detection of gases and vapors. Different industries and monitoring scenarios may require different applications of the skill sets. This Body of Knowledge (BoK) will be used by AIHA® to establish a framework for the development of training programs and knowledge/skill assessment tools, as well as for the improvement of the state of professional industrial hygiene (IH) practice at multiple levels of knowledge and responsibility.

This BoK is not intended to define or stipulate employer hiring criteria. It is the employer's responsibility to ensure that each employee understands his or her specific job and has met the minimum criteria established by relevant regulations, standards, and the specific industry, facility, or project.

Skills:

Performance-based training incorporates performance tasks (performance assessments) that build on content knowledge. These demonstrations of knowledge and skills document competence. At a minimum, competent users of DRIs at each knowledge level defined below will be able to successfully demonstrate competence at that knowledge level as outlined in Section 1.

Demonstration of Competence:

Demonstration of competence for field use of DRIs may take different forms, such as successful performance on a written or computer-based examination or a hands-on demonstration of skills regarding instrument operation and maintenance.

Knowledge Areas:

Section 1 describes the knowledge that constitutes competent field use of DRIs to detect and measure gases and vapors in the atmosphere.

Knowledge Levels:

As used in this BoK, "knowledge" is the practical understanding of the subject area, while "skill" is the learned capacity to use knowledge in practical applications. Knowledge and skills combined together form the measurable competencies summarized in this document. The knowledge levels generally illustrate increasing professional experience and responsibility as defined below and in Section 1.

Body of Knowledge

Awareness Level - Works under close supervision with review by supervisor or Operations Level person to ensure compliance with proper procedures. Essential minimum criteria:

- Basic concepts in atmospheric testing
- Common terminology
- Current manufacturer's training specific to instrument used
- Site- or industry-specific protocols, procedures, and compliance requirements
- Awareness of the specific atmospheric contaminants being monitored
- Decision making criteria regarding the contaminants potentially or actually present

Operations Level - Works without close supervision in subject area, normally without routine compliance review, but consults Specialist Level person(s) for assistance as needed; may supervise performance of work by others, which can include Awareness Level personnel. Has subject-area expertise and may be consulted for assistance; provides hands-on assistance when needed; charged with instrument maintenance. Essential minimum criteria:

- Awareness Level knowledge listed above
- Knowledge of the specific atmospheric contaminants being monitored, sampling strategy to monitor them, and their site- specific sources
- Selection, maintenance, and calibration of appropriate instruments for specific environments

Specialist Level - Provides expert guidance to the Operations Level person(s); knowledgeable about pertinent standards; may set company-level procedures; responsible for high-level data interpretation; selects appropriate instruments for purchase and use; sets exposure sampling strategies and appropriate alarms. Essential minimum criteria:

- Operations Level knowledge listed above
- Sampling strategies for both known and unknown environments/atmospheres

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Competence Levels for Field Use of Direct-Reading Instruments for Detection of Gases and Vapors

Chemical Properties

Awareness Level

Know basic contaminant properties relevant to direct-reading instruments (DRIs) use in atmospheric testing to utilize appropriate sampling technique (where to sample)

Operations Level

Understand properties relevant to DRI use in atmospheric testing and know atmospheric conditions that can change during the work shift

Specialist Level

Understand chemical properties relevant to DRIs use in atmospheric testing and why atmospheric conditions may change during the work shift

1.0 Instrument Use and Operation
(all per manufacturer's specifications, at a minimum)

Awareness Level

1.1. Apply basic application of the site- and instrument-specific knowledge of what the instrument will detect and what it will not detect

1.2. Identify basic operational settings such as On/Off

1.3. Demonstrate proper charging of instrument

1.4. Recognize sensor confirmation and acknowledgment

1.5. Interpret the meaning of different audible and visual alarms

1.6. Understand instrument response time and how long it will take for the instrument to give a reading

1.7. Assess conditions that impact display of correct information, e.g., lower explosive limit (LEL) readings in oxygen-rich or oxygen-deficient environments

1.8. Understand the importance of fresh-air setup

1.9. Understand the reasons for calibration

1.10. Assess calibration conditions (clean vs. contaminated atmosphere)

1.11. Conduct full calibration, calibration checks and functional testing per manufacturer recommendation

1.12. Conduct functional (bump) tests and calibration checks

1.13. Differentiate between automated and manual calibration

1.14. Differentiate between calibrating LEL sensors to pentane and methane

Operations Level - Intentionally has no items/statements

Specialist Level - In addition to Awareness Level knowledge:

1.15. Assess reasoning for changing alarm settings from the factory default settings

1.16. Configure alarm settings

1.17. Perform data download from the instrument

2.0 Instrument Maintenance

(all per manufacturer's specifications, at a minimum)

Awareness Level

2.1. Demonstrate an awareness and understanding of the effects of temperature and humidity on instrument

2.2. Demonstrate proper use of battery packs (storing, replacing, charging of different battery types)

2.3. Identify key indicators of a malfunctioning instrument

2.4. Perform proper cleaning of instrument components, as applicable

2.5. Perform proper storage of the instrument (short-term)

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2.0 Instrument Maintenance

(all per manufacturer's specifications, at a minimum)

...continued

Operations Level - In addition to Awareness Level knowledge:

2.6. Assess calibration or service frequency required in response to loss of sensitivity

2.7. Perform proper procedures to replace components, as applicable

2.8. Perform proper procedures to update instrument and sensor firmware

2.9. Assess impacts of site-specific atmosphere on instrument performance to address maintenance needs and frequency

Specialist Level - Intentionally has no items/statements

3.0 Troubleshooting

Awareness Level

3.1. Apply knowledge of site-specific safety policies and procedures

3.2. Apply knowledge of manufacturer's documents about instrumentation

3.3. Perform proper procedures to address conditions that impact display of correct information

3.4. Understand what to do if fresh-air setup will not work

3.5. Inform designated contact in your organization about instrument problems and exposure issues related to instrument readings

Operations Level - In addition to Awareness Level knowledge:

3.6. Assess instrument malfunction

3.7. Recognize an instrument's accuracy

Specialist Level - Intentionally has no items/statements

4.0 Data Interpretation

Awareness Level

4.1. Implement appropriate site-specific action in response to direct reading criteria

4.2. Demonstrate an awareness of when to evacuate

Operations Level - In addition to Awareness Level knowledge:

4.3. Demonstrate an awareness of when to recommend data logging in response to anticipated peak or acute exposures

Specialist Level - In addition to Operations Level knowledge:

4.4. Understand when and how to track trends in long-term data to review chronic exposures

5.0 Incident Response

Awareness Level - Intentionally has no items/statements

Operations Level

5.1. Identify and ensure completion of necessary steps for immediate action

Specialist Level - Intentionally has no items/statements

6.0 Instrument Selection

Awareness Level

6.1. Identify atmospheric contaminants of concern

Operations Level - In addition to Awareness Level knowledge:

6.2. Promote and conduct visual inspections and surveys necessary to identify hazards and select appropriate DRI

6.3. Recognize when to use secondary devices in addition to primary instrument

6.4. Select the appropriate instruments for anticipated environments

Specialist Level - In addition to Operations Level knowledge:

6.5. Identify limitations/advantages of the specific instrument in the anticipated environment

7.0 Instrument Technology and Operational Theory

(all per manufacturer's specifications, at a minimum)

Awareness Level

7.1. Understand what the instrument measures (e.g., property, range, contaminant)

Operations Level - In addition to Awareness Level knowledge:

7.2. Recognize specific sensor technology used in the instrument

7.3. Understand how instruments work

7.4. Apply correction factors specific to the instrument

7.5. Apply site- or atmosphere-specific sampling strategies

7.6. Assess site- and instrument-specific interferences and cross-sensitivities

7.7. Recognize sensor poisons

Specialist Level - Intentionally has no items/statements

8.0 Regulatory Framework

Awareness Level - Intentionally has no items/statements

Operations Level - Intentionally has no items/statements

Specialist Level

8.1. Demonstrate the importance of identifying and adhering to relevant voluntary consensus standards such as the American National Standards Institute (ANSI), National Fire Protection Association (NFPA), the International Organization for Standardization (ISO), or an equivalent international standard

8.2. Demonstrate the importance of identifying and adhering to relevant regulations

Resources:

The following resources, reviewed by designated Subject-Matter Experts, are provided as one means to gain knowledge in use of DRIs for gas and vapor detection.

- Direct Reading Instruments for Gases, Vapors and Particulates. Ch. 17 in *Fundamentals of Industrial Hygiene,* 6th ed., B.A. Plog, PJ Quinlan, Eds.; 2012.
- *Hazardous Gas Monitors: A Practical Guide to Selection, Operation and Applications,* 1st ed. J. Chou, McGraw-Hill Professional; 1999.
- Detection Devices Air Sampling Instruments, Unit 6 in *IAFF Training for Hazardous Materials: Technician Manual,* 9th ed. International Association of Fire Fighters (IAFF) publication No. 0031; 2001.
- *Direct-Reading Instruments for Gas and Vapor Detection,* A monograph of the ACGIH Air Sampling Instruments Committee, American Conference of Governmental Industrial Hygienists (ACGIH) Publication #ASI18; 2009.
- *An Overview of Air Sampling Methodologies: Instrumentation and Analytical Techniques for Evaluation of Atmospheric Contaminants*. A monograph of the ACGIH Air Sampling Instruments Committee, American Conference of Governmental Industrial Hygienists (ACGIH) Publication #ASI22; 2009.
- *Calibration of Gas and Vapor Samplers*. A monograph of the ACGIH Air Sampling Instruments Committee, American Conference of Governmental Industrial Hygienists (ACGIH) Publication #ASI20; 2009.
- *Confined Space Testing*. A monograph of the ACGIH Air Sampling Instruments Committee, American Conference of Governmental Industrial Hygienists (ACGIH) Publication #ASI16; 2009.
- EPA Training Manual #7 - Emergency Response to Hazardous Material Incidents. Publication No. 3115 (EPA Manual 165.16, Document No. 540-R-95-143); 1995. *Includes information on using direct-reading instruments for evaluating and mitigating the release of hazardous materials.*
- Safety Requirements for Confined Spaces. American Society of Safety Engineers standard ANSI/ASSE Z117.1-2009; 2009.
- Important Instrumentation and Methods for the Detection of Chemicals in the Field, AIHA® Publication AINB13-777; 2013.
- OSHA Technical Manual (OTM) – OSHA Instruction TED 01-00-015 [TED 1-0.15A]. (http://www.osha.gov/dts/osta/otm/otm_toc.html)
- Hazardous Waste Operations and Emergency Response. 29 CFR 1910.120, Occupational Safety and Health Administration, U.S. Department of Labor. (http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9765)
- Permit-Required Confined Spaces. 29 CFR 1910.146, Occupational Safety and Health Administration, U.S. Department of Labor. (http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=STANDARDS&p_id=9797)
- Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents. National Fire Protection Association standard NFPA 472; 2008. (http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=472)
- Comparable international and non-U.S. standards, as applicable.

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